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App. Ser. No. 10/656,812
Atty. Dkt. No.: 038724.52699US
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	: 10/656,812	Confirmation No.	:	7094
Applicant	: WOLFGANG DANZER, et al.			
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Examiner	: MARIA ALEXANDRA ELVE			
Docket No.	: 038724.52699US			
Customer No.	: 23911			
Title	: **LASER WELDING OF NONFERROUS METALS BY USING LASER DIODES AND PROCESS GAS**			

Customer No. 23911

SUBMISSION OF PRIORITY DOCUMENT TRANSLATIONS

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

As noted in the Amendment filed November 22, 2006, the Applicants are submitting herewith certified English translations of the two foreign documents to which priority is claimed in the present case, German Patent Application No. 101 10 701.3 and German Patent Application No. 101 10 702.1.

If there are any questions regarding this submission or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit

Account No. 05-1323 (Docket #038724.52699US).

Respectfully submitted,

November 30, 2006

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TRANSLATOR'S DECLARATION

I, CHRISTA SCHAERTEL, declare and say:

1. That I reside at 413 South Fayette Street, Alexandria, Virginia 22314;

2. That I am thoroughly familiar with the German, French and English languages, holding Translator's and Interpreter's Diplomas from the Institute of Interpreting and Foreign Languages, Goettingen, Germany, and the Chamber of Industry and Commerce of Wiesbaden, Germany;

3. That I translated the German Patent Application 101 10701.3 with the title
Laser Welding of Nonferrous Metals By Using Laser Diodes and Process Gas,

written in the German language; and

That the attached is a correct English translation of the above-mentioned German-language document to the best of my knowledge and belief.

Christa Schaertel
Christa Schaertel

Date: 11/28/06

FEDERAL REPUBLIC OF GERMANY

Priority Certificate
Concerning
The Filing of a Patent Application

File Number:	101 10 701.3
Filing Date:	March 6, 2001
Applicant/Holder:	LINDE AKTIENGESELLSCHAFT Wiesbaden/DE First Applicant: Linde Gas AG, Höllriegelskreuth/DE
Title:	Laser Welding of Nonferrous Metals by Using Laser Diodes and Process Gas
IPC:	B 23 K, B 01 J

The attached items are a correct and precise copy of the original documents of this patent application.

(Seal)

München, October 23, 2003
German Patent and Trademark Office
The President
By Order
(Signature)
Wehner

P01043-DE/GTG = EM-GTG0815b

March 6, 2001 - Obermüller

Specification

LASER WELDING OF NONFERROUS METALS BY USING LASER DIODES AND PROCESS GAS

The invention relates to a process gas for use during laser welding of nonferrous metallic workpieces by means of a laser beam focused onto the workpiece to be welded, a laser diode being used as a laser beam source.

The invention also relates to a process for the laser welding of nonferrous metals, in which case a laser diode or several laser diodes are used as the laser beam source, at least one focused laser beam being guided to a workpiece surface to be machined, and a process gas flow being guided against the workpiece surface.

The characteristics of laser radiation, particularly the intensity and the good focusing capability, have had the result that nowadays layers are used in many material machining fields. Laser machining systems are often used in connection with

computerized numerical controls (CNC). Corresponding laser machining systems are known in numerous variations.

Within the scope of the invention, a focused laser beam is a laser beam which is essentially focused on the workpiece surface. In addition to the predominantly used method with the laser radiation focused on the workpiece surface, the invention can also be used in the case of the seldom used variant in which the radiation is not focused exactly onto the workpiece surface.

In many methods of laser material machining, metallic and/or other material is heated to temperatures at which a reaction takes place with the enveloping gases. In many cases, industrial gases are therefore used in order to be able to carry out these material machining processes more effectively, faster and/or with an improved quality.

With respect to laser welding, it is known to use inert protective gases, such as helium or argon. Nitrogen is also sometimes used. In some cases, additions of active gas fractions, such a carbon dioxide, oxygen or hydrogen are also admixed to argon or nitrogen.

The tasks of the process gases during laser welding are

multiple. The process gases determine, among other things, to a large extent, the economic efficiency, the quality and the process reliability of the laser welding.

Diode lasers as a laser beam source, in comparison to solid-state lasers (for example, Nd:YAG-lasers) and gas lasers (for example, CO_2 lasers) are of interest during laser welding because of a number of advantages: Diode lasers represent an extremely efficient artificial light source. They can be installed without great expenditures and, as a rule, can sufficiently operate with a conventional power supply as the energy supply. They are small and very compact. Further, they have a high efficiency (with 40 to 50% approximately five times higher than in the case of a conventional laser system). Finally, they have a long lifetime (normally at least 10,000 hours).

So far, diode lasers have not been successful in practice for laser welding of nonferrous metals. Insufficient laser welds occurred, particularly with low welding depths.

From our own published German Patent Document DE 199 01 898 A 1, it is known to use a process gas for the laser welding of low-alloy steel types and zinc-coated steel types which

contains, in addition to helium and possibly argon, at least oxygen with a fraction of up to 30 % by volume. The laser welding of nonferrous metals is not considered in detail in German Patent Document DE 199 01 898 A1.

Specifically during the laser welding of nonferrous metals, because of reflections of the radiation on the workpiece surface, frequently only a low coupling-in of energy takes place which, as a rule, does not permit a qualitatively high laser welding process using laser diodes as the laser beam source.

It is therefore an object of the invention to indicate a process gas and a process of the initially mentioned type which permit an improved laser welding of nonferrous metals by means of laser diodes. A high-quality laser welding process was to be provided. In particular, by means of the process gas, in addition to controlling and reducing the plasma, a laser weld was to be achieved at a high welding speed, with a deep penetration, of a high quality and with good seam geometries.

According to the invention, this object is achieved in that the process gas contains at least oxygen.

Within the scope of the invention, in contrast to ferrous

metals and types of steel, nonferrous metals are particularly aluminum materials and alloys, magnesium materials and alloys, nickel base materials and alloys, copper materials and alloys and/or brass-containing materials.

It is decisive for the invention that surprisingly oxygen in the process gas causes a change of the weld pool. Instead of the otherwise observed rotating of the weld pool in the upward direction (away from the machined workpiece surface), an unexpected rotating of the weld pool takes place in the downward direction, that is, in the direction toward the workpiece surface to be machined.

Probably because of the oxygen from the process gas in the weld pool, the surface tension is reduced, which leads to the desired result of a high-quality laser welding process with a deep penetration.

As an embodiment of the invention, the process gas contains between 10 and 100% by volume oxygen. This information relates to wanted constituents of the process gas and not to unwanted or production-caused impurities. The oxygen may therefore also contain normal impurities in the case of a fraction of 100% by volume. Advantageously, the fraction of oxygen in the process

gas is at 15 and 90% by volume, preferably between 45 and 85% by volume, particularly preferably between 55 and 80% by volume.

As a further development of the invention, the process gas is fed in the direction of the normal line (at an angle of 90E) of the workpiece surface.

In addition to oxygen, the process gas can contain argon, nitrogen, helium and/or other precious gases. The process gas can advantageously also contain carbon dioxide at a fraction of up to 50% by volume.

Particularly process gases

- of a binary gas mixture with the constituents oxygen and argon,
- of a binary gas mixture with the constituents oxygen and nitrogen,
- of a binary gas mixture with the constituents oxygen and carbon dioxide,
- of a ternary gas mixture with the constituents oxygen, argon and helium,
- of a ternary gas mixture with the constituents oxygen, argon and carbon dioxide,

or

- of a ternary gas mixture with the constituents oxygen, argon and nitrogen

have been successful.

As an embodiment of the invention - particularly also for the above-mentioned binary and ternary gas mixtures respectively - laser diodes with a wavelength of from 700 to 1,300 nm, preferably of from 800 to 1,000 nm, are suitable for the laser welding. Thus, high-power laser diodes in the infrared range are preferred for the invention.

Within the scope of the invention, particularly high-power laser diodes with a laser power of from 0.5 to 6 kW, preferably between 1 and 4 kW, can be used.

In tests, for example, during the laser welding of a workpiece made of AlMgSi1 with a thickness of 2 mm by means of a laser diode with a laser power of 3 KW, the surprising effect of the oxygen in the process gas according to the invention was confirmed. In this case, using a process gas fed concentrically to the laser beam at 90E onto the workpiece surface, the welding took place at a welding speed of 1 m/min. Here, on the one hand, as a comparative test, according to the prior art, argon was fed as a process gas and, according to the invention, a

process gas of oxygen was used under otherwise identical conditions.

In comparison to the welding using argon, the advantages according to the invention became clearly apparent. Thus, an analysis of micrographs proves that the welded surface existing in the thus obtained cut, in the case of the laser welding with argon, has a value of $0.93mm^2$, while in the section for the laser welding with oxygen, a surface of $7.76\ mm^2$ was obtained. Thus, the effect during laser welding could be increased more than eight times only by means of changing the process gas from argon to oxygen.

P01043-DE/GTG = EM-GTG0815b

March 6, 2001 - Obermüller

CLAIMS:

1. Process gas for use during laser welding of nonferrous metallic workpieces with a laser beam focused onto the workpiece to be welded, a laser diode being used as a laser beam source, characterized in that the process gas contains at least oxygen.

2. Process gas according to Claim 1, characterized in that the process gas contains between 10 and 100% by volume oxygen.

3. Process gas according to Claim 1 or 2, characterized in that the process gas contains between 15 and 90% by volume oxygen, preferably between 45 and 85% by volume oxygen, particularly preferably between 55 and 80% by volume oxygen.

4. Process gas according to one of Claims 1 to 3, characterized in that the process gas is fed in the direction of the normal line (at an angle of 90E) to the workpiece surface.

5. Process gas according to one of Claims 1 to 4, characterized in that, in addition to oxygen, the process gas contains argon, nitrogen, helium and/or other precious gases.

6. Process gas according to Claims 1 to 5, characterized in that, in addition to at least oxygen, the process gas contains carbon dioxide of a fraction of up to 50% by volume.

7. Process gas according to one of Claims 1 to 6, characterized in that the process gas consists of a

- of a binary gas mixture with the constituents oxygen and argon,
- of a binary gas mixture with the constituents oxygen and nitrogen,
- of a binary gas mixture with the constituents oxygen and carbon dioxide,
- of a ternary gas mixture with the constituents oxygen, argon and helium,
- of a ternary gas mixture with the constituents oygen, argon and carbon dioxide,

or

- of a ternary gas mixture with the constituents oxygen, argon and nitrogen.

8. Process for the laser welding of nonferrous metals, a laser diode or several laser diodes being used as the laser beam source, at least one focused laser beam being guided to a workpiece surface to be machined, and a process gas flow being guided against the workpiece surface,
characterized in that a process gas according to one of Claims 1 to 7 is used.

9. Process according to Claim 8,
characterized in that laser diodes of a wavelength of from 700 to 1,300 nm, preferably of from 800 to 100 (1,000 ? translator) nm, are used.

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March 6, 2001 - Obermüller

ABSTRACT:

LASER WELDING OF NONFERROUS METALS BY USING LASER DIODES AND PROCESS GAS

The invention relates to a process gas for use during laser welding of nonferrous metallic workpieces with a laser beam focused onto the workpiece to be welded, a laser diode being used as a laser beam source. According to the invention, the process gas contains at least oxygen. The process gas can have between 10 and 100 % by volume oxygen. In addition to oxygen, the process gas can also contain argon, nitrogen, helium and/or other precious gases, as well as carbon dioxide of a fraction of up to 50% by volume.